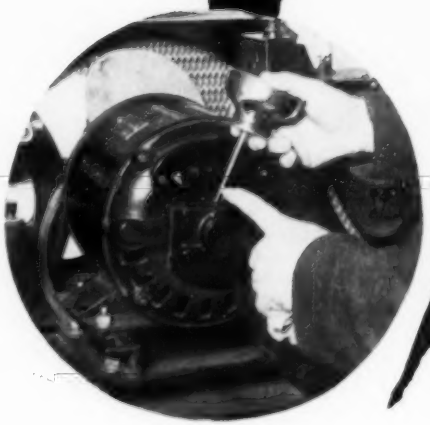
BULLETIN 848

CARE OF ELECTRIC MOTORS

CORNELL EXTENSION BULLETIN



Forrest B. Wright

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Care of Electric Motors

FORREST B. WRIGHT

ELECTRIC motors require relatively little care in comparison with other farm-power units, such as internal combustion engines, tractors, and horses. The care that they do require is, however, as essential as for any other machine if they are to be kept in service. It takes only a minute or two for a mistreated motor to burn out and become useless. As a guide to proper motor care, the following points are suggested:

1. Keep motor bearings properly lubricated.
2. Keep motors clean, well ventilated, and dry.
3. Keep commutators and brushes on universal and repulsion-induction motors in good condition.
4. Be sure that motors are supplied with the correct voltage.
5. Do not overload a motor. Use adequate motor size for the job.
6. Be sure the motor shaft and the load are free to turn before trying to start a motor that has not been run in some time.
7. Use overload protection.
8. Replace worn bushings and bearings.
9. Be sure the belts are not too tight and are correctly aligned.

1. Keep motor bearings properly lubricated.

As a rule, the bearings on each end of the motor need lubrication. The kind of lubricant and the frequency of lubrication vary widely with the type of bearings on the motor and with the amount of work the motor does. No single rule can be given for all types of motors except to say that the oiling should be exactly according to the manufacturer's instructions. These instructions, if not furnished with the motor, may be obtained from the manufacturer or from some local dealer who is familiar with the motor. When asking for oiling instructions, be sure to give the name of the manufacturer, the type of motor, the model number or code, and the purpose for which the motor is used. All of this information, except the last item, is usually found on the motor name plate (figure 1).

Motor bearings need exactly the right amount of lubricant. Too much lubricant is almost as bad as not enough because the excess only runs out and soaks into the coils and other working parts of the motor where it collects dirt and destroys insulation.

The following points should always be kept in mind when lubricating motors:

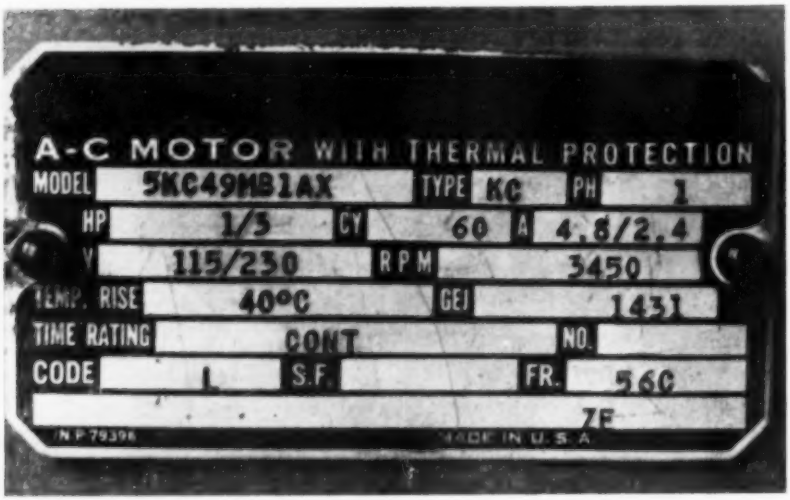


Figure 1. Motor name plate

Figure 2. Good care important

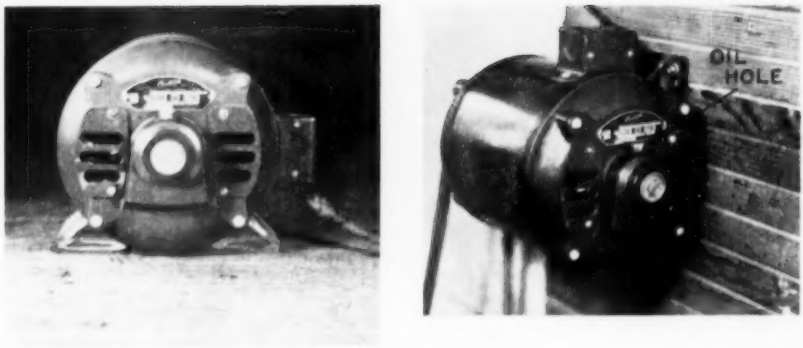
An electric motor is a tireless, highly efficient, and thoroughly dependable servant if given good care

1. Use only the correct *grade* of clean lubricant. Light oil should not be used where heavy oil or grease is recommended, or heavy oil should not be used where light oil or grease is recommended. The use of diluted or dirty lubricants may do more harm than good.

2. Use the correct *amount* of lubricant. Do not put 10 drops in a bearing that requires only 5 drops. The extra oil will run out of the bearing and damage the inside of the motor.

3. The *frequency* of lubrication is important. Use the correct amount of the proper grade of lubricant at the correct time intervals.

4. If a motor is to be operated where the temperature may drop below 30°F, use an oil that has been especially treated for use in cold weather.



A B

Figure 3. A motor mounted on a horizontal surface (A) and on a vertical surface (B)
Note that the oil hole points upward. Note also that in B the plates have been shifted 90 degrees to bring the oil hole on top of the bearings.

5. After oiling a motor, wipe off any excess oil on the outside of the motor so it will not collect dust and dirt.

6. For safety, and to prevent flooding the bearings, do not oil a motor while it is running.

7. Oil-lubricated motors should always be mounted so the oil will not run out of the bearings. For example, if a level-mounted motor is to be changed and mounted on a vertical wall, the end shields should be shifted 90 degrees to bring the oiling system to a horizontal position (figure 3). Motors should not be mounted on end unless the bearings are especially designed to operate in that position.

Some of the newer motors are equipped with sealed ball bearings that contain enough lubricant for many years of service (figure 4). Such bearings should not be oiled unless the oiling instructions so indicate.

Figure 4. A motor with sealed bearings

Many of the refrigerating units now on the market have "sealed units" where the motor and other working parts are hermetically sealed in a housing with enough lubricant to last the life of the machine (figure 5). Such a unit needs no lubrication.

2. Keep motor clean, well ventilated, and dry

An electric motor generates heat when it is working. This heat must be removed or the motor will burn out.

Figure 5. A sealed unit on a refrigerator

The motor and compressor are sealed in the tank-like housing with enough lubricant to last the life of the machine. The sealed container keeps oil in as well as dirt and moisture out

In open motors, the heat is usually removed by air circulating through the motor. In sealed-in motors, the oil takes the heat away.

Air-cooled motors have a fan mounted on the shaft on the inside of the frame. This fan forces air to circulate through the motor (figure 6). The air enters through the openings in one of the end plates, passes around the coils where it picks up the heat, and out through the openings in the other end plate. The fan, the openings in the end plates, and the air passages around the coils may become clogged with dust and lint so the flow of air is greatly restricted (figure 7). A motor in such a condition if fully loaded and run for any considerable length of time may overheat and burn out.

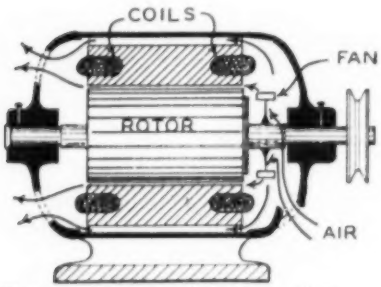


Figure 6. Diagram of one type of motor, showing coils, rotors, and fan

A fan on the shaft circulates air through the motor

In addition to restricting the flow of air, the accumulated dirt in the motor may work into the bearings and cause excessive wear, or may interfere with the operation of the starting mechanism inside the motor. A periodic cleaning eliminates these troubles.

To clean a motor:

1. Be sure that the motor is completely disconnected from the circuit. Detach the cord or disconnect the wires from the motor.

2. Remove the belt or otherwise disconnect the motor from the load.

3. Take the motor apart by removing the end plates. As parts are removed from the motor, mark them or observe carefully how they are assembled so you can re-assemble them correctly.

4. If a vacuum cleaner with attachments or an air hose is available, suck or blow out as much of the loose dirt of the motor as you can.

5. Clean with dry rags, or a dry paint brush, as much of the remaining dirt as you can and then wash the metal parts except coils with a non-inflammable cleaning fluid. Be sure that the air passages through the frame of the motor and through the rotor are clear. Do not apply cleaning fluid

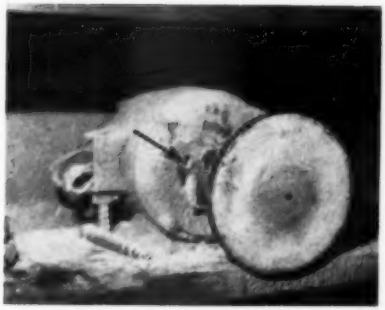


Figure 7. A motor on a sander, with the air passages almost completely obstructed with wood dust (arrow)
This is an excellent way to burn out a motor

to the coils of the motor unless it is necessary to remove oily dirt, because such solvents may damage the insulation on the wires. Wipe the motor parts dry with a clean cloth.

6. While the motor is apart, inspect the starting switch, the commutator, and the brushes, if any, to see whether they need repair.

7. Repair or replace any worn or damaged parts.

8. Re-assemble the motor, being sure that all parts go back in their correct positions. Tighten the end-plate nuts one after the other and a little at a time until all are brought down together. Be sure that the end plates fit tightly all the way around and that the shaft turns freely.

9. Lubricate the bearings of the motor according to instructions.

10. Reconnect the motor to the circuit and note its operation.

11. If it runs normally, reconnect the motor to the load.

Ventilation. Air-cooled motors need to have a good circulation of air around them. They should not be placed in poorly ventilated or overheated enclosures. For example, never place a pump motor in a small, poorly ventilated shelter which is exposed to the hot sun.

Moisture. Because moisture is a natural enemy of motors, they are best installed in dry rather than damp places. A motor that has been flooded should be thoroughly dried before it is started.

3. Keep commutator and brushes, if any, in good condition

Universal and repulsion-induction motors have on the armature a cylinder or disc of copper bars interspaced with strips of mica (figures 8, 9, and 10). This is called the *commutator*. Riding on this commutator under spring pressure are two or more carbon brushes. Friction between the commutator and brushes wears the brushes and sometimes cuts a groove in the commutator. With a dirty motor, this wear may be rapid enough to destroy the brushes in a short time. Replace worn brushes with new ones. Keep brush guides clean and free from gum so the brushes will move freely and be pressed firmly against the commutator by the brush springs.

If the commutator is worn, a condition known as "high mica" may result; that is, the copper sometimes wears faster than does the mica and leaves the mica projecting above the surface of the copper as shown in figure 10 at A. These mica ridges pre-

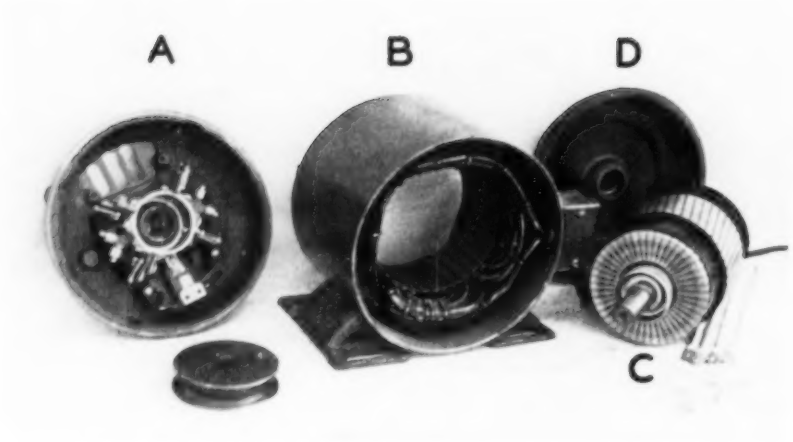
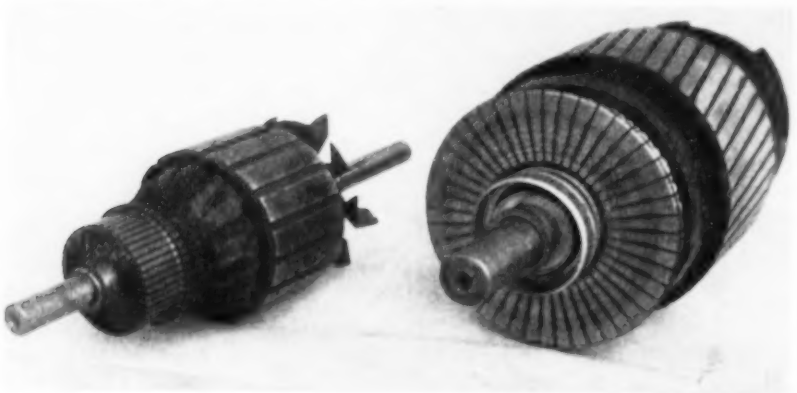


Figure 8. A repulsion-induction motor with commutator and brushes
A, an end plate with brush holder and brushes; B, the stator or frame with main windings; C, the armature with commutator on near end; D, the other end plate

vent the brushes from making good contact with the copper and therefore interfere with the operation of the motor. This is usually accompanied by pronounced arcing at the brushes. When this condition exists, the commutator should be turned down on a lathe and sanded until it is smooth. This is a particular job and should be done by an experienced person.

If the commutator is only dirty, wipe it with a cloth dampened in cleaning fluid. On open-end motors, this can sometimes be done without taking the motor apart. The current must be turned off during this opera-

Figure 9. Two armatures, showing two types of commutators



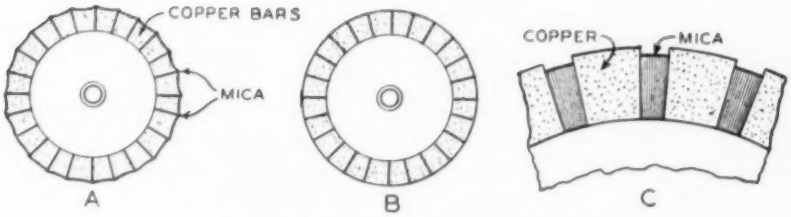


Figure 10. Steps in commutator repair

A, high mica on a commutator
B, commutator after turning down
C, mica under cut; if the mica in the commutator was undercut before turning down, it should be undercut after turning as shown here

tion. Never use emery cloth to clean a commutator, as the emery dust may short-circuit the copper bars. Fine sandpaper is safe.

4. Be sure that motors are supplied with correct voltage

A motor connected near the end of a long or overloaded circuit may not receive enough voltage to enable it to carry its load. This will cause the motor to slow down or to stop. In either case, unless properly protected by overload protective devices, the motor will quickly burn out. Also, this frequently happens to motors when connected to a long length of small-sized lamp cord. All wiring supplying current to motors should be large enough to carry the necessary current with not more than from 2 to 5 per cent drop in voltage. Wire sizes to use for various horsepower motors and length of circuits are given in table 1.

Dual-voltage motors are built to operate on either of two voltages. The types used on farms are built for 115 and 230 volts. The connections for the motor leads for each of these voltages is illustrated in figure 11. Be sure that these connections are correctly made for the voltage to which the motor is to be connected.

5. Do not overload a motor

A common cause of burned out motors is overloading. A motor overloaded to the point where its speed is noticeably reduced draws an excessive

Figure 11. Wiring connections

A, connection for 115 volts; B, connections for 230 volts

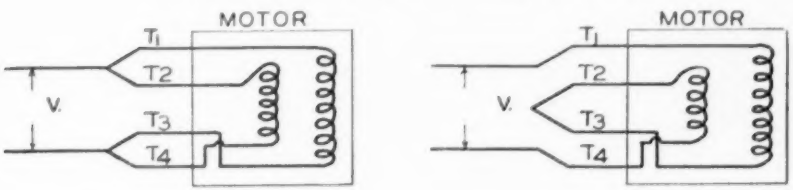


Table 1. Wire Sizes for Individual Single-Phase Motors, Based on 2 Percent Voltage Drop on Full-load Current

Motor horsepower	Volts	Approximately full-load amperes	Length of run in feet														
			50	75	100	150	200	250	300	350	400	500	600	700	800	900	1000
1/20	115	2.4	14	14	14	14	12	12	10	10	10	8	8	8	6	6	6
1/12	115	2.6	14	14	14	14	12	12	10	10	10	8	8	6	6	6	6
1/8	115	2.8	14	14	14	14	12	12	10	10	8	8	8	6	6	6	6
1/6	115	3.2	14	14	14	12	12	10	10	8	8	8	6	6	6	4	4
1/4	115	4.6	14	14	12	12	10	8	8	8	6	6	6	4	4	4	2
1/3	115	5.1	14	14	12	10	10	8	8	6	6	6	4	4	4	2	2
1/2	115	7.4	14	12	10	8	8	6	6	6	4	4	2	2	2	2	1
3/4	115	10.2	12	10	10	8	6	6	4	4	4	2	2	2	1	0	0
1/6	230	1.6	14	14	14	14	14	14	14	14	14	14	12	12	12	10	10
1/4	230	2.3	14	14	14	14	14	14	14	14	12	12	12	10	10	10	8
1/3	230	2.6	14	14	14	14	14	14	14	12	12	12	10	10	10	8	8
1/2	230	3.7	14	14	14	14	14	12	12	12	10	10	10	8	8	8	6
3/4	230	5.1	14	14	14	14	12	12	10	10	10	8	8	6	6	6	6
1	230	6.5	14	14	14	12	12	10	10	8	8	8	6	6	6	4	4
1-1/2	230	9.2	14	14	12	12	10	8	8	8	6	6	6	4	4	4	2
2	230	12.0	14	12	12	10	8	8	6	6	6	4	4	4	2	2	2
3	230	17.0	10	10	10	8	8	6	6	4	4	4	2	2	2	1	1
5	230	28.0	10*	10*	8	6	6	4	4	2	2	2	1	0	0	00	00
7-1/2	230	40.0	8†	8†	6	4	4	2	2	2	1	0	00	00	000	000	0000
10		50.0	6*	6*	6*	4	2	2	1	1	0	00	000	000	0000	0000	250‡

* Type RH or RHW in cable or raceway, all types in air. For other types of wire in cable or raceway use next size larger.

† For wires in cable or raceway use next size larger.

‡=thousand circular mils.

amount of current, which in turn generates excessive heat. The reduced speed of the motor decreases the effectiveness of the cooling fan and the temperature of the motor rises to a point where the insulation burns from the windings. This means rewinding or replacing the motor, either of which is expensive. Always use adequate horsepower for the load involved. Do not expect a small motor to carry a large motor load.

Some types of motors, such as shaded-pole and split-phase used on fans, grinders, and washing machines, have relatively low starting power and should not be called upon to start under a full load. One should start these motors with the lightest possible load and apply the main load only after the motor has come up to speed.

The capacitor and repulsion-induction types of motors are built to start under full load.

6. Be sure the motor shaft and load are free to turn before trying to start a motor that has not been run in some time

It sometimes happens, particularly when a motor has not been started in some time, that rust, corrosion, dirt, or some foreign object gets into bearings or other moving parts of the driven machine so that it does not turn freely. Such a condition may stall the motor and burn it out immediately. For this reason, before starting such a machine, turn it over by hand if possible to make sure that it is free.

7. Use overload protection

Under the best of operating conditions there is always the possibility of unintentional or accidental overloads being placed on a motor. Also, low-voltage conditions sometimes unavoidably occur. For these reasons, motors should be protected with overload and low-voltage protective devices. This applies particularly to motors on automatic machines, such as milk coolers and water pumps, and to motors on non-automatic machines that are operated without an attendant present. The following types of overload protective devices are in common use:

Time delay fuses protect against overload and low voltage.

Thermal overload elements in motor switch protect against over-load and low voltage.

Thermal overload elements built into motor frame protect against overload, low voltage, and overheating of the motor from any cause.

An overload protective device which is responsive to current only should be rated or set at not more than 125 percent of full-load current rating for motors marked for a temperature rise of not more than 40°C., and at not more than 115 percent for all other types of motors. The sizes of time-delay fuses to use for common horsepower sizes of motors are indicated in table 2.

For detailed instruction on motor protection, refer to Cornell Extension Bulletin 673, *Protection for Electric Motors*.

Table 2. Sizes of Time-Delay Fuses for Motor-running Protection

Motor horsepower	Motor ampere rating	Size of time-delay fuse			
		Ordinary service	Heavy service	Maximum size	
				40°C. motor+	All other motors
115 volts					
1/6	3.2	3.2	3.5	4	4
1/4	4.6	4.5	5	6.25	5.60
1/3	5.1	5.60	6.25	7	7
1/2	7.4	8	9	10	9
3/4	10.2	10	12	12	12
1	13.0	15	15	17.50	15
1-1/2	18.4	20	25	25	25
2	24.0	25	30	30	30
230 volts					
1/3	2.6	2.8	3.2	3.5	3.5
1/2	3.7	4	4.5	5	4.5
3/4	5.1	5	5.6	7	6.25
1	6.5	6.25	7	9	8
1-1/2	9.2	9	10	12	12
2	12	12	15	15	15
3	17	17.5	20	20	20
5	28	30	35	35	35
7-1/2	40	40	45	50	50
10	50	50	60	70	60

8. Replace worn bushings and bearings

If the bushings or bearings on a motor become badly worn, the rotor may be pulled out of line by the belt until it drags on the stationary field-pole pieces. This produces an overload condition, stalls the motor, and causes it to burn out. Motors, particularly those with sleeve bearings, which have been in service for some time or which have been run without adequate lubrication should be inspected for this wear.

Figure 12. Inspecting a motor bearing for wear

If the pull of the belt was to the right or to the left, then push and pull on the shaft in the directions of the arrows to see whether the shaft is loose in the bearing

A quick inspection can be made by removing the belt and pulley from the motor and then pushing back and forth on the motor shaft in line with the pull of the belt as shown in figure 12. If there is a noticeable "chuck" in the bearings, it is time to replace the bushing; or if it is a ball-bearing motor, a new bearing may be needed. When making this test, do not confuse sidewise chuck of the shaft with endplay chuck. Most motors are designed with a small amount of endplay on the rotor. This is a normal condition.

The renewal of bushings may require the use of a press to force out the old and press in the new bushings. Also, the new bushings may need to be reamed a little to obtain an exact fit on the shaft. If a press and a reamer are not available at home, take the motor to a repair shop for this job.

9. Be sure the belts are not too tight and are correctly aligned

Too tight a belt causes excessive wear on bearings; too loose a belt slips and causes excessive wear on the belt. V-belts need not be so tight as flat belts. Also, the pulleys should be in line so the belt runs straight (figures 13 and 14). Desirable belt sizes and number to use in relation to pulley diameters and motor sizes are indicated in table 3.

Table 3. Belts Recommended According to Size of Drive, Pulley, and Horsepower Motor*

Diameter of motor pulley in inches	Number and type of belts required for the horsepower of 1750 RPM motors							
	Horsepower							
	½	¾	1	1½	2	3	5	7½
2	FHP	FHP or 1-A	†	X	X	X	X	X
2½	FHP	FHP or 1-A	†	X	X	X	X	X
3	1-A	1-A	1-A	2-A	2-A	3-A	5-A	8-A
3½	1-A	1-A	1-A	2-A	2-A	3-A	4-A	7-A
4	1-A	1-A	1-A	1-A	2-A	2-A	3-A	5-A
4½	1-A	1-A	1-A	1-A	1-A	2-A	3-A	5-A
5	1-A	1-A	1-A	1-A	1-A	2-A	3-A	4-A
5½	1-A	1-A	1-A	1-A	1-A	1-B	2-B	3-B
6	1-A	1-A	1-A	1-A	1-A	1-B	2-B	2-B
7	1-A	1-A	1-A	1-A	1-A	1-B	2-B‡	2-B
8	1-A	1-A	1-A	1-A	1-A	1-B‡	1-B	2-B
9	1-A	1-A	1-A	1-A	1-A	1-B‡	1-B	2-B

* Belt type FHP: width at top 3/8 inch, thickness 5/10 inch
Belt type A: width at top 1/2 inch, hickness 11/32 inch
Belt type B; width at top 21/32 inch, thickness 7/16 inch

† Pulleys less than 3 inches in diameter should not be used for motors of 1 horsepower or larger.

‡ Type A could be used instead of type B.

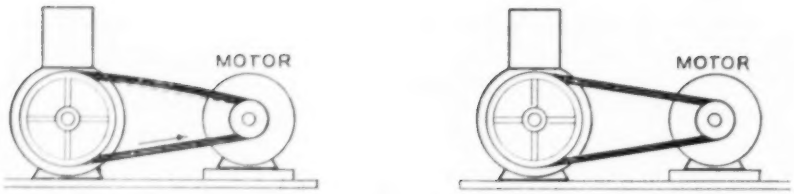


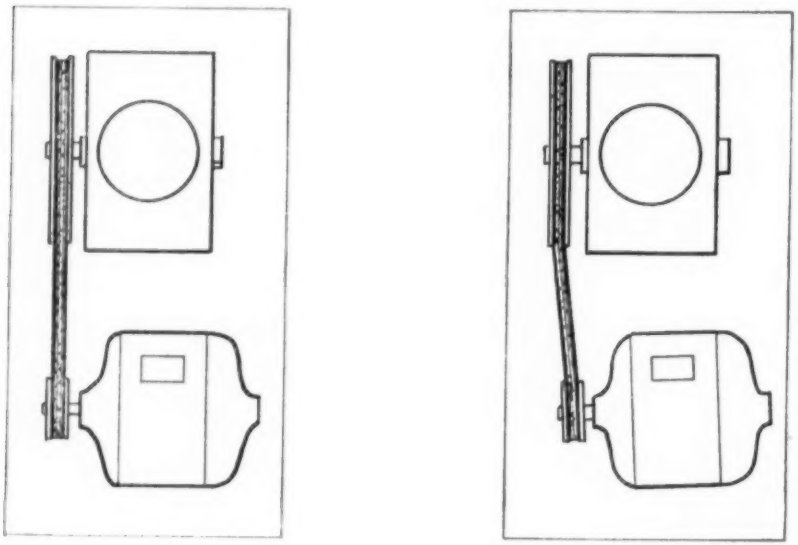
Figure 13. Tightness of belt

A, normal tightness. A belt should not be too tight and the pull should be on the bottom if possible.

B, belt too tight. This causes excessive wear on the bearings.

Figure 14. Pulley properly lined (A) and out of line (B)

A pully out of line causes excessive wear on the belt.



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